ILLINOIS NATURAL HISTORY SURVEY

PERFORMANCE REPORT

JOB PROGRESS REPORT

As Required By

FEDERAL AID IN WILDLIFE RESTORATION ACT

ILLINOIS

Section of Wildlife Research

Federal Aid Project No. W-66-R-23

Cooperative Wildlife Research

By

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20 September 1983

Performance Report

Annual Job Progress Report

State: Illinois

Project Number: W-66-R-23

Project Type: Research

Project Title: Cooperative Wildlife Research

Sub-Project VI; Title: Illinois Squirrel Investigations

Period Covered: 1 July 1982 - 30 June 1983

Study No.: VI-A; Title: Strategies for Achieving Multiple Benefits from Managed Forests--Wood Products and Squirrel Populations, a Pilot Study.

Study Objectives:

1. To provide a system for predicitng the impact on squirrels of current forestry and other practices taking place in the principal forest communities of Illinois.
2. To formulate new strategies for integrating the ecological requirements of squirrels within forest management programs, with the use of published and unpublished research data and practical experience.
3. To use simulation modeling to formulate harvest management strategies for gray and fox squirrels.
4. To integrate forest management strategies with control of hunter harvests of squirrels to achieve sustained yields of wood products and squirrel populations.

Job No.: VI-A-1; Title: Strategies for achieving multiple benefits from managed forests--production of wood products and squirrels, a pilot study.

Objectives: To develop models for predicting the effects of current forest management practices on squirrels, including the costs of constraints placed on the production of wood fiber because of squirrel needs; to formulate new strategies for integrating forest management objectives with the ecological needs of gray and fox squirrels; to integrate forest management strategies with control of hunter harvests as needed in type forest communities to achieve sustained yields of wood products and squirrels.

(a) Activity:

(1) Attempts to locate models for growth of trees and stands that mimic actual stand development in the principal forest types of Illinois. One system called TWIGS (the woodsman's ideal growth projection system), designed for use on the Apple II microcomputer, appears to offer sufficient flexibility to allow us to simulate the interaction between squirrel needs and timber management guidelines as stands mature and are cut in various ways. This system employs individual tree, distance independent, growth, and mortality models in conjunction with timber management and economic evaluation subsystems to simulate stand development. Thus, changes in timber stands can be simulated over time in great detail (Belcher 1982). We plan to obtain a copy of this program and will begin modifying it to include the effects of various cutting regimes on squirrels and the economic consequences of a multiple-use program of squirrels and timber production.

(2) We have selected the forest types that occupy the target land area and currently support the bulk of the huntable squirrel population in Illinois, a total of 8 upland and 4 bottomland forest types (Table 1). By way of indicating

the importance of each type to squirrels, we have attempted to locate all published and unpublished livetrapping data providing information on squirrel densities in these forest types (Table 2). Mixed oak stands support the most squirrels in the state, particularly during the spring months, and silver-maple-elm-dominated stands support the fewest squirrels (Table 2).

(3) We have been compiling, from our own research and published data, average seed yields per 2-inch-diameter classes for tree species important as squirrel foods in Illinois. An example is shown in Table 3. Knowledge of food requirements of squirrels, coupled with tree seed production, can be used to construct minimum stand stocking rates for the principal tree species present in a forest type and may also be used in simulations of timber management options to consider their effects on squirrels. An example using oaks, hickories, and black walnut is shown in Table 4.

(4) We have begun to prepare descriptions of the various forest types in Illinois, including distribution, timber management options, squirrel densities, food and shelter needs in each type, and probable effects of various timber management options on subsequent squirrel densities.

(b) Target Date for Achievement:

Progress Report - 30 September 1984

Final Report - 30 September 1985

(c) Date of Accomplishment: on schedule.

(d) Significant Deviations: none.

(e) Remarks: none.

(f) Recommendations: none.

(g) Cost: Federal - \$11,553 State - \$3,851 Total - \$15,404

LITERATURE CITED

Belcher, D. 1982. TWIGS, a description paper. U.S.D.A. Forest Service, North Central Forest Exp. Sta., St. Paul. 26pp.

Downs, A. 1944. Estimating acorn crops for wildlife in the southern Appalachians. J. Wildl. Manage. 8:339-340.

Gingrich, S. 1971. Management of young and intermediate stands of upland hardwoods. U.S.D.A. Forest Service Research Pap. NE-195. 26pp.

Goodrum, P., V. Reid, and C. Boyd. 1971. Acorn yields, characteristics, and management criteria of oaks for wildlife. J. Wildl. Manage. 35:520-532.

Nixon, C., M. McClain, and L. Hansen. 1980. Six years of hickory seed yields in southeastern Ohio. J. Wildl. Manage. 44:534-539.

Zarger, T. 1946. Yield and nut quality of the common black walnut in the Tennessee Valley. Pp. 118-124 in the 37th Annual Report of Northern Nut Growers Association, Wooster, OH.

Job No.: VI-A-2; Title: Appraisal of harvest management strategies for gray and fox squirrels using simulation modeling.

Objectives: To formulate harvest management strategies for gray and fox squirrels.

(a) Activity: Managers have considered both gray and fox squirrels to be generally underharvested and thus have provided hunters with long seasons and liberal bag limits (Uhlig 1957, Jordan 1971, Allen 1954). Several studies have shown, however, that both species can be over exploited on publically owned forests in the face of unregulated hunting pressures (Allen 1943, Baumgartner 1943, Nixon et al. 1974, Nixon et al. 1975). In Illinois, for example, squirrels on 2 public forests, Kankakee River State Park and Moraine View State Park, have evidenced the unstable densities and unrealistic juvenile:adult age ratios thought to be indicative of overharvested populations of fox squirrels (Nixon et al. 1974). Attempts to simulate the effects of hunting mortality on the subsequent demography of both species must recognize that both natality and mortality rates change with the level of exploitation. For the initial simulations of fox squirrel population dynamics, input data were derived from a demographic study of an unhunted fox squirrel population in Vermilion County, Illinois. Reproductive and survival rates, some of which were negatively related to densities of adult females, were incorporated into the simulations. Immigration was not included because we wanted to determine the level of harvest that

compensating reproductive and survival rates could sustain in isolated woodlots. Emigration was included in mortality. A 10-year simulation revealed that stable densities of 1.4 squirrels/ha were maintained at 0% harvest levels (Figure 1). These densities were lower than those generally found in the Vermilion County study, mainly because we ignored immigration, which may play an important role in the dynamics of fox squirrel populations. Harvest rates of 20, 40 and 60% severely reduced the simulated fox squirrel densities (Figure 1), suggesting that without immigration, only low harvest rates could be maintained. Unfortunately, only limited information on immigration rates and the effects of density on these rates is available. We removed adult male or female, or both, fox squirrels from 5 study grids to evaluate impact of adults on density regulation (Hansen and Nixon 1982). We were not able to separate immigrants from squirrels born on these grids and therefore lumped reproduction and immigration as recruitment. Results of this study revealed that recruitment of some sex and age classes was density dependent. When density dependent factors are incorporated into the simulations, a more realistic projection of squirrel numbers is obtained (Figure 2). These simulations, which show the results of 0, 40 and 80% harvest rates, indicate that spring densities are depressed in harvested populations, but that fall densities recover rapidly. In fact, fall densities under the 40 and 80% harvest regimes slightly exceeded those of the unharvested simulation. This seemingly nonsensical observation reflects the effects of strongly density dependent recruitment. Similar observations were made in the

field when all adult females were removed (Hansen and Nixon 1982). Although fall densities tended to recover rapidly in the harvest simulation to densities similar to those in the unexploited simulation, the age structure differed between exploited and harvested populations (Figure 3). Age ratios in the harvested populations were skewed towards young squirrels, whereas those in the unexploited population were skewed towards adults (Figure 3). We might expect densities of the heavily exploited squirrel populations to be less stable than those of the unexploited population for at least 2 reasons. First, young squirrels generally have lower and less consistent reproductive and survival rates than adults. Secondly, the density dependent effects, especially recruitment rates, depend on consistently high annual reproductive rates, which seldom occur in fox or gray squirrel populations (Harnishfeger et al. 1978; Thompson 1978; Nixon et al. In Press). We would expect recruitment rates to be low during poor reproductive years, regardless of size of the adult population. Low fall densities in some years and high densities in others would result. These simulations also assume that the squirrels are in continuous habitat or in areas with adjacent unhunted habitat. Squirrel populations in isolated woodlots, as indicated by the initial simulations (Figure 1), would likely respond differently to exploitation. The effects of varying reproductive rates and differences in woodlot size and isolation will be the subject of more extensive simulations in the future. These results will be relevant to management strategies in the more extensively

farmed areas. We also will attempt similar simulations for gray squirrels and incorporate hunter effort and differential vulnerability of the sex-age classes of squirrels to harvest into the simulations.

(b) Target Date for Achievement:

Progress Report - 30 September 1984

Final Report - 30 September 1985

(c) Date of Accomplishment: on schedule.

(d) Significant Deviations: none.

(e) Remarks: none.

(f) Recommendations: none.

(g) Cost: Federal - $11,553 State - $3,851 Total - $15,404

LITERATURE CITED

Allen, D. 1943. Michigan fox squirrel management. Mich. Dept. Conserv. Game Div. Publ. 100. 404pp.

Allen, J. 1954. Gray and fox squirrel management in Indiana. 2nd ed. Indiana Dept. Conserv. P-R Bull. 1. 112pp.

Baumgartner, L. 1943. Fox squirrels in Ohio. J. Wildl. Manage. 7:193-202.

Hansen, L., and C.M. Nixon. 1982. Annual Progress Report

Harnishfeger, R.L., J.S. Roseberry, and W.D. Klimstra. 1978. Reproductive levels in unexploited woodlot fox squirrels. Trans. Ill. State Acad. Sci. 71:342-355.

Jordan, J. 1971. Yield from an intensively hunted population of eastern fox squirrels. U.S.D.A. Forest Service Res. Pap. NE-186. 8pp.

Nixon, C.M., R.W. Donohoe, and T. Nash. 1974. Overharvest of fox squirrels from two woodlots in Western Ohio. J. Wildl. Manage. 38:67-80.

Nixon, C.M., M.W. McClain, and R.W. Donohoe. 1975. Effects of hunting and mast crops on a squirrel population. J. Wildl. Manage. 39:1-25.

Nixon, C.M., S.P. Havera, and L. Hansen. In Press. Effects of nest boxes on fox squirrels. Amer. Midl. Nat.

Uhlig, H. 1957. Gray squirrel populations in extensively forested areas in West Virginia. J. Wildl. Manage. 21:335-341.

Job No.: VI-A-3; Title: Publication of manuscripts and reports.

Objective: To help defray the cost of publishing manuscripts and reports resulting from project study investigations including a squirrel management bulletin.

(a) Activity:

One manuscript was published during this segment:

Nixon, C., M. McClain, R. Landes, L. Hansen, and H. Sanderson. 1983. Response of suppressed hickories to release cutting. Wildlife Society Bull. 11:42-46.

Three additional manuscripts were prepared and are in various stages awaiting publication:

Nixon, C., S. Havera, and L. Hansen. Effects of nest boxes on fox squirrels. Accepted for publication by American Midland Naturalist.

Havera, S., C. Nixon, and H. Belcher. Ovarian parameters of fox squirrels. Submitted to J. Mammalogy.

Hansen, L., and C. Nixon. Effects of adults on the demography of fox squirrels (_Sciurus niger_). Undergoing review.

(b) Target Date for Achievement:

Progress Report - 30 September 1984

Final Report - 30 September 1985

(c) Date of Accomplishment: on schedule.

(d) Significant Deviations: none.

(e) Remarks: none.

(f) Recommendations: none.

(g) Cost: Federal - $2,250 State - $750 Total - $3,000

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Date: 20 September 1983

Table 1. Forest types of importance to squirrels in Illinois.

Forest Type	Ecological Relationships
Upland types:	
Sugar Maple-Basswood	Well drained moist soils and ravines in southern Illinois and well drained soils in northern Illinois.
Beech-Sugar Maple	Moist, well drained soils on north and east lower slopes and ravines in southern and east-central Illinois.
Post Oak-Blackjack Oak	Found on dry sites, chiefly upper south and west slopes and ridges in southern Illinois, claypan soils in south-central Illinois, and sandy soils in Western Illinois.
Bur Oak	Dry, exposed sandy plains, south and west exposures on uplands and on moist slopes, along floodplains throughout Illinois.
White Oak-Black Oak-Red Oak	The most abundant upland type in Illinois found on both glaciated and nonglaciated well drained soils throughout the state.
White Oak	Moderately moist, well drained soils throughout the state.
Black Oak	Moderately dry to dry sites, most common on sandy soils in central and southern Illinois.
Northern Red Oak	Mesic sites such as coves, north and east facing slopes in central and southern Illinois.
Bottomland types:	
Silver maple-Elm	Well drained sites along floodplains throughout Illinois. Frequently flooded sites are nearly pure silver maple. Dutch elm disease has reduced the elm component in this type.

Table 1. cont.

Forest Type	Ecological Relationships
Bottomland types (cont.):	
Pin oak-Sweetgum	Pure pin oak is more abundant in Illinois. Generally found on poorly drained soils as an early successional stage in the regrowth of bottomland forests. Most common in southern and western Illinois.
Cottonwood	Pioneer type along with willow on moist bare soil in floodplains throughout the state.
Hackberry-Elm-Ash	Low ridges, flats and sloughs in first bottoms along rivers; terrace flats and sloughs and occassionally pioneers on floodplains. Most abundant in southern Illinois.

Table 2. Average fall and spring squirrel densities reported for the principal forest types present in Illinois. Estimates developed from livetrapping and tagging squirrels.

Forest Type	Number of Stands	Stand Age	Species	Squirrels/10 acres Fall	Squirrels/10 acres Spring
Uplands:					
Sugar Maple-Basswood					
Low compliment of oak	1	mature	Fox	8	4
High compliment of oak	1	mature	Fox	11	10
Beech-Sugar Maple	3	mature	Fox and Gray	8	6
Post Oak-Blackjack Oak	2	mature	Fox	8	7
White Oak-Black Oak-Red Oak	13	mature	Fox and Gray	12	9
	1	immature	Fox and Gray	--	9
White Oak	3	mature	Fox	11	11
Bur Oak	1	virgin	Fox	20	--
Black Oak	1	immature	Fox	5	2
Northern Red Oak	3	mature	Fox and Gray	10	6
Osage Orange Hedge	1	mature	Fox	3/mile of hedge	
Bottomlands:					
Pin Oak-Sweetgum[a]	1	mature	Fox and Gray	16	--
Silver Maple-Elm	1	mature	Fox	4	--
Cottonwood	1	mature	Fox	7	--
Hackberry-Elm-Green Ash	1	mature	Fox	21[b]	--

[a] no census data available for pure pin oak.

[b] only one census.

Table 3. Seed production for selected oaks, hickories, and black walnut by dbh class.

dbh (inches)	White[a] oak	Black[b] oak	Red[b] oak	Blackjack[a] oak	Post[a] oak	Shagbark[c] hickory	Mockernut[c] hickory	Pignut[c] hickory	Black[d] walnut
	Average Number of Sound Nuts and Acorns								
8	52	-	-	-	454	16	12	-	478
10	278	260	40	40	626	45	56	48	830
12	505	405	200	746	778	88	155	139	1,181
14	742	550	510	1,107	907	132	254	230	1,533
16	968	695	900	1,492	1,102	176	350	319	1,884
18	1,195	840	1,310	1,876	1,253	220	449	411	2,236
20	1,421	985	1,560	2,237	1,426	264	548	502	2,584
22	1,658	1,130	1,540	2,599	1,578	307	646	592	2,939
24	1,885	1,275	1,400	2,983	1,728	351	744	683	-

[a]Source: Goodrum et al. 1971.

[b]Source: Downs 1944.

[c]Source: Nixon et al. 1980.

[d]Source: Zarger 1946.

Table 4. Number of trees required for A and B level stocking in oak dominated stands, and minimum stocking levels of selected oaks, hickories, and Black walnut needed to supply 40% (oaks and hickories) and 10% (Black walnut) of the annual squirrel diet. Squirrel densities assumed to average 1 per acre.

Average dbh	Trees per acre[a]		Minimum number of trees per acre							
	A level	B level	White oak	Black oak	Red oak	Post oak	Blackjack oak	Shagbark hickory	Mockernut hickory	Black walnut
8	300	177	74	-	-	11	-	91	122	3
10	207	122	24	22	44	8	9	32	27	2
12	153	88	5	12	7	6	5	17	10	2
14	117	68	3	7	3	5	3	12	6	1
16	93	53	2	5	2	4	2	9	5	1
18	75	43	2	3	1	4	2	7	4	1
20	63	35	2	3	1	3	2	6	3	1
22	52	30	1	3	1	3	2	5	3	1
24	45	25	1	2	1	3	1	5	2	1

[a]Source: Gingrich 1971: A and B level represent the maximum and minimum number of trees needed to fully utilize the space available on one acre. The number of trees between the maximum and minimum number for each dbh class represents trees available for timber harvests.

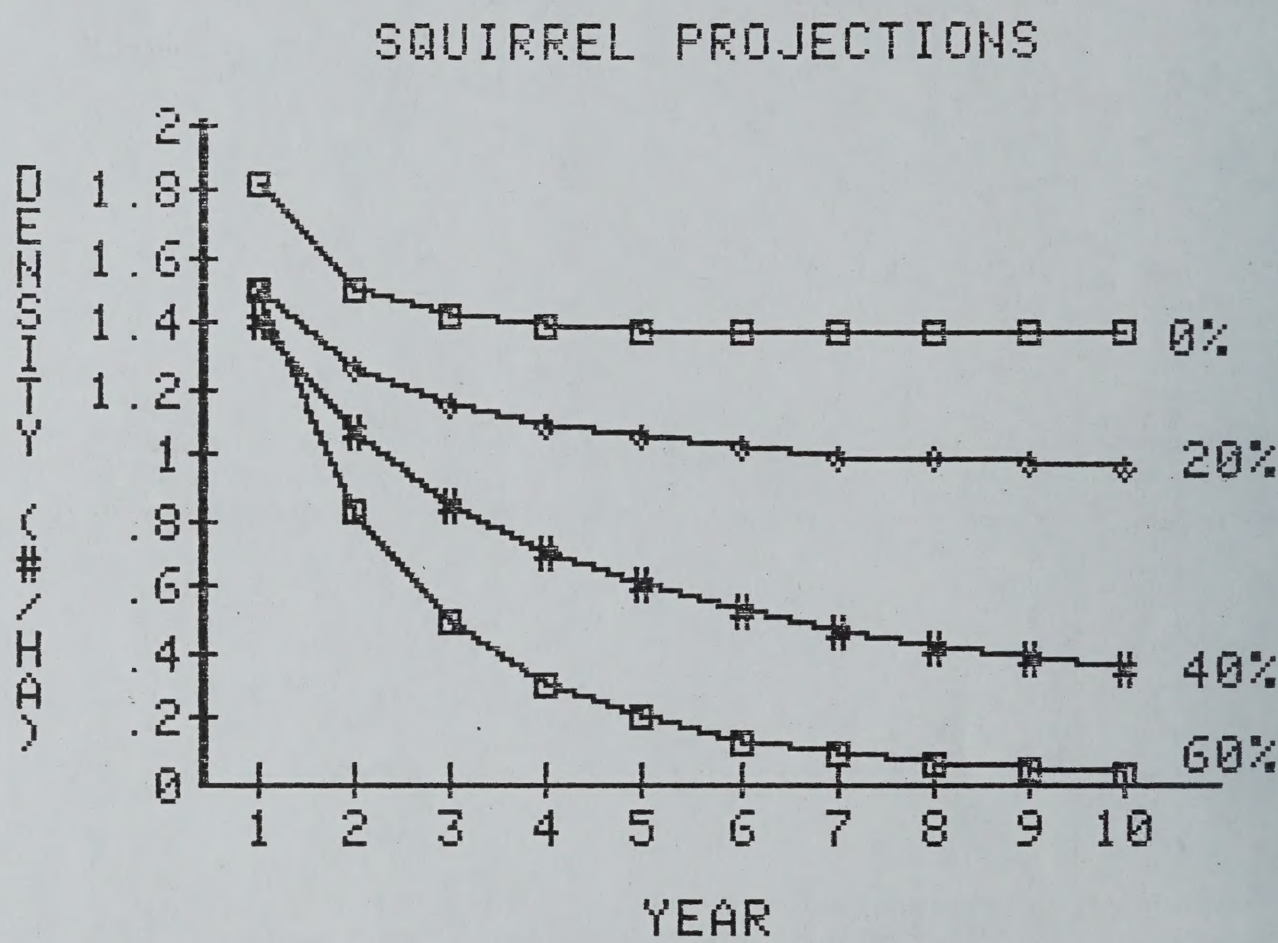

Figure 1. Projected squirrel densities (number per ha) for an unhunted population and for populations from which 20%, 40%, and 60% of the squirrels had been removed in the fall. Immigration was not included.